VOLUME VI. NUMBER 4

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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PUBLISHED BI-MONTHLY

JULY–AUGUST, 1912

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.
FOREIGN AGENTS: WILLIAM WESLEY & SON,
28 ESSEX ST., STRAND, LONDON.

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$2.00 per annum. Single numbers, 35 cents.

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PLATE XV.

N

a

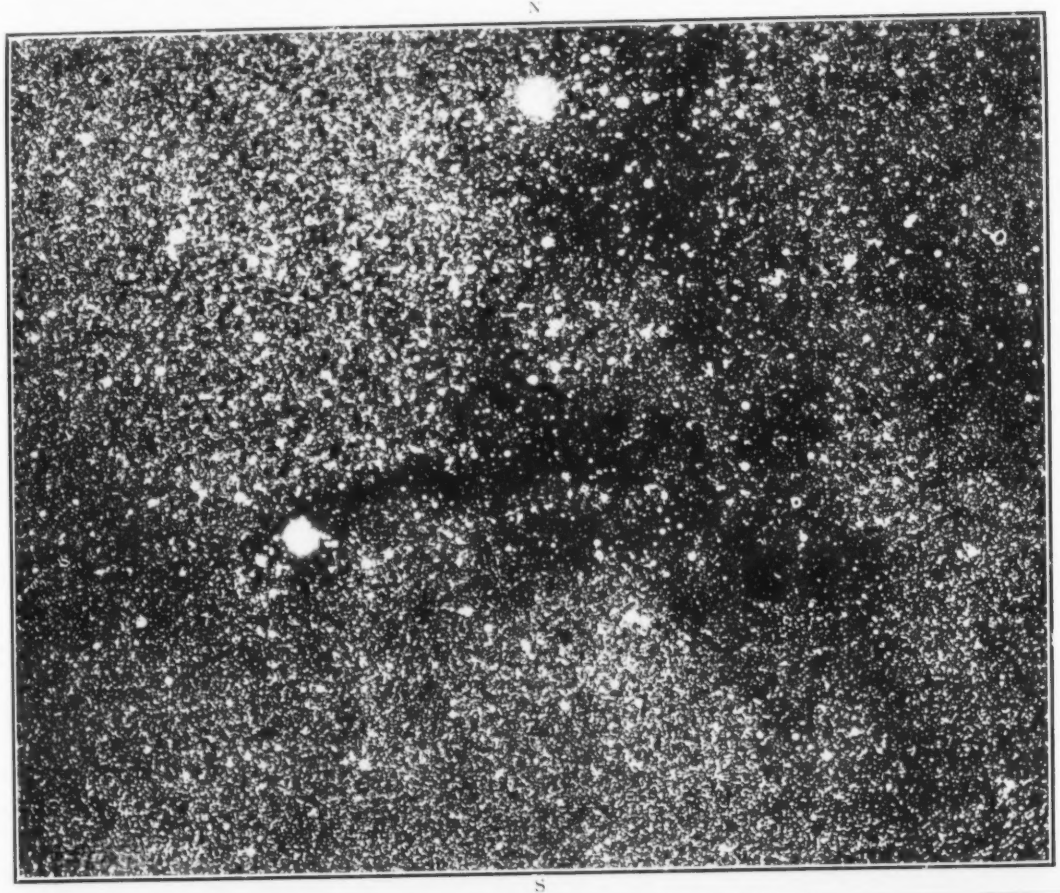
a'

S

THE NORTH AMERICA NEBULA IN CYGNUS

Photographed by Professor Max Wolf, with 16-inch lens. The dark rings are well shown where a and a' meet.

N



S

NEBULA NEAR π^2 CYGNI AT END OF DARK CHANNEL

Photographed by Professor Max Wolf, with 16-inch lens. The dark part in the centre of the plate shows many absorption rings.

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THE DARK STRUCTURES IN THE MILKY WAY

By T. E. Espin

THERE is an interesting postscript to one of Caroline Herschel's letters to her nephew Sir John Herschel, who was then about to proceed to the Cape. It runs:—

"I wish you would see if there was not something remarkable in the lower part of the Scorpion to be found, for I remember your Father returned several nights and years to the same spot but could not satisfy himself about the uncommon appearance of that part of the heavens. It was something more than a total absence of stars (I believe)."

As is well known Sir John actually found blank spaces in the heavens without *the smallest star*, and a list of them is given in the Cape Observations. The effect of such a starless field on Sir William Herschel is well described in another of Caroline Herschel's letters, in which she says:—

"Remembering having heard your Father after a long awful silence exclaim 'Hier ist wahrhaftig ein loch im Himmel'! and, as I said before, stopping afterwards at the same spot, but leaving it unsatisfied, etc."

It is clear from the first of these extracts that Sir William Herschel thought, or was believed to have thought "that there was something more than a total absence of stars."

On January 16, 1898, I was sweeping for red stars in Perseus, and came upon what I took at first to be a cloud, although to the eye the sky was perfectly clear. On the return sweep some 40′ south I came upon it again. After a lapse of twenty minutes the place was re-examined with the same result. Similar observations were made on January 24 and 25. Dr. Halm and Mr. Heath, at Edinburgh, on February 17, found it without much difficulty, but Professor Perrine, with the 12-in Refractor at the Lick Observatory, and with the comet seeker, considered it simply a hole, and apparently not a remarkable one, in the Milky Way. In 1911 I again accidentally came across it, having quite forgotten the former observation. The mirrors of the 17¼ had not long before been silvered, and the hazy, misty appearance was quite remarkable. It had to my eye somewhat the appearance of a faint reddish haze. The photographs of Professor Wolf show it as a "hole" in the Milky Way. An inspection of the various photographs of the Milky Way demonstrates that these "holes" are of common occurrence. Some are quite small and others very large, such as the "cave" in Aquila or the familiar "coal sack" in the southern skies. Now what are these "holes"? It is quite unthinkable that they are tunnels driven right through the Milky Way. Indeed no tunnel could possibly have the appearance they present for such a tunnel would, indeed, be black in the centre but from the centre would brighten up to the edges. Such is not at all the appearance. Suddenly there appears a figure of inky blackness on the photographs, quite sharp and well defined. There must be then some other explanation. And the only apparently feasible one is that they are areas of absorption. In the case of certain nebulæ the fact that there is such absorption has been clearly shown by Mr. Franks in his paper on "Dark Nebulosities," in *Monthly Notices*, Vol. LXV., p. 160. Four photographs are given, concerning which Mr. Franks states "that the outer and attenuated edge of the nebula has cooled down so rapidly, relatively to the central hot and luminous mass, that where it crosses the latter it simply stops its light by absorption and produces a dark band."

THE "CAVES" IN AQUILA

Photographed with a 6-inch portrait lens by Professor Max Wolf. The bright star is α Aquila.

He further suggests that the peculiar dark gaps in certain irregular nebulæ, may be "extensions in the line of sight of feebler and cooler nebulosity which intercept the light behind." Professor Wolf (*Monthly Notices*, Vol. LXIV., p. 338) notes "that all the extended nebulæ discussed at our observatory are situated in the interior of regions containing only a very small number of faint stars," and again, Mr. Kopff from an exact enumeration of the stars in the neighborhood of the Orion and Cygnus Nebulæ shows that "nearly all faint stars have disappeared from the immediate surroundings of these nebulæ, though they are ten times more numerous both in the nebulæ and far outside." It seems, therefore, highly probable that the extent of the nebulæ, as revealed in photographs taken with the most powerful instruments we have at our disposal, is only a small fraction of the real extent of these bodies. What we see is only the path of energy enkindling in parts the nebula mass. Some of the planetary nebulæ are surrounded by rings of light and darkness. The one in Andromeda, photographed with five exposures of different lengths at the Lick Observatory, shows a nucleus and two bright and two dark rings. The planetary nebulæ pass into the spiral, as is demontrated by the photographs and also by their spectra, the intermediate type giving bright and dark lines. We may well believe then that the rings of the planetary nebulæ are real rings, or the appearance is due to shells of alternate radiation and absorption. The spiral nebulæ are characterized with enormous equatorial extension compared with their polar diameter. There are no bodies in the heavens which more clearly give the impression of a motion of rotation than the spiral nebulæ, yet so far no alteration has been detected. It may, indeed, be objected that the period of exact observation is too short; on the other hand it is possible that the appearances which suggest rotation may have a different interpretation. The spirals may be emanations from the real poles and not from the equators, while the appearances may rather correspond to our auroral light than to actual streams of matter. Such streams of energy, passing into a highly refracting medium, might by per-

sistent refraction assume the spiral form. The influx of cool material to the equator might possibly account for the absorption band which apparently severs in some cases the nebula into two, and in others causes the dark spaces and semi-circular holes, and elliptical, or ring formations. A careful study of the dark spaces shows that the ring shape is quite general, I have made a thorough examination of the photographs of the η Argûs Nebula taken by Russell with the 13-inch and exposures of $5^h\,43^m$, $8^h\,0^m$, $12^h\,12^m$, and have traced the ellipses or rings of absorption from one photograph to another. The results of increasing exposure are very striking. Ellipses in the shorter exposure are gradually filled in in the longer, and partially obliterated by nebulosity or faint stars. The matter can be carried further by the magnificent plate in the *Harvard Annals*, Vol. LX., p. 8, taken with the 24-inch, with 4 hours exposure. In the Northern Hemisphere a critical examination of the America Nebula in Cygnus yields the same result. North of 57 Cygni is an oval of absorption, giving to the nebula a sharply defined curve. The nebula re-appears on the opposite side again, in some patches preceding 57. The star 56 Cygni is attended by an oval well marked on the preceding side, and having 56 nearly in the N. Focus. On oval at the south of the nebula gives the isthmus appearance. The whole nebula is surrounded with a vast circular dark marking, very broad on the following side, in which lies ξ Cygni. The general impression given by the whole is that of a globe surrounded by an absorbing medium, and this in turn composed of a vast number of what are most like absorption vortex rings, seen at all angles and consequently appearing as ellipses. Coming up at all angles, they cut out the light of the background in one direction, while they are plunged beneath the nebulous masses in another. A very remarkable oval is seen at R. A. $20^h\,51^m$, Decl. $+\,45°$. This has a major axis of $20'$ pointing to P 350°, and a minor axis of $12'$. The tree like formation N. of α Cygni, to which attention was called many years ago by Ranyard, on closer examination appear to be due to a series of absorption rings interrupting each other. The star

PLATE XVIII.

N

S

ONE OF THE "CAVES" IN AQUILA

Photographed by Professor Max Wolf, with 28-inch Reflector.

PLATE XIX.

SPIRAL NEBULA H. V. 24 COMÆ

Photographed with the 60-inch at Mount Wilson. Exposure 5 hours, March 6, 7, 1910, showing the Nebula cut in two by what is probably an absorption ring.

α Cygni is nearly on the major axis of a vast ellipse extending over 24 minutes in R. A. and with a minor axis of one degree. The star γ Cygni, if examined in Wolf's photograph in his "Milchstrasse," is seen to be situated in a mass of narrow ovals pointing to P 284°, well marked on the preceding side where they run through a thinner part of the galaxy. A narrower ring, marked by stars, is seen in Barnard's and Wolf's larger photographs well defined N.P. and S.P. of that star and apparently passing under the nebulous masses. A similar series of ellipses is found on Barnard's photograph of χ Cygni extending south of that star and with major axis generally parallel to the Milky Way. The curious "cave," N. P. α Aquilæ, seems to be the result of at least three ellipses, parts of which emerge and intersect at such an angle as to cause complete absorption of the background. In the famous "coal sack" in the Southern Hemisphere a similar series of rings may be traced, and there is the appearance of a dark Saturn-like object. Photographs of all parts of the Milky Way taken with any aperture and sufficiently long exposure tell us that this ring formation is general. It is a well known fact that as regards the great gap in the preceding branch of the Milky Way, so noticeable in the early autumn sky, the charts of Argelander and the photographs show that it arises from the absence of the brighter stars rather than fainter ones. May this not be due to absorption, dimming down a section which really is as bright as the following branch? Nay, may not the whole length of the great bifurcation be due to a similar cause? The great breadth of the Argo-Cygnus section and the extreme narrowness of the Milky Way on the opposite side of the heavens have led to the speculation that we are in space nearer to the former than the latter. May not these well known phenomena be intensified by the further speculation of a vast absorption ring, so situated as to cause an apparent bifurcation in the summer galaxy, and greatly curtail the glories of the winter galaxy? It has been pointed out by Slipher that in certain binaries with spectra of the B type the calcium lines remain sharp and unchanged, whereas other lines are diffuse. This result was obtained in the

first instance in the case of stars in Scorpio, but afterwards a similar fact was found to hold good in other parts of the heavens, *viz.*, in Orion and Perseus. This is apparently inexplicable, unless an absorption medium, exterior to and unconnected with the star is admitted. If such an absorption medium is admitted, the further question arises, Is it merely local, or does it with more or less density pervade the whole of our universe? It has been shown in *Knowledge*, for January, 1912, that the results of the examination of the larger Magellanic cloud fully bear out Herschel's dictum that we have here a *multum in parvo* of our universe. An inspection of a photograph of this object shows that we have a galactic circle of stars, bright on one side of the ring, and dimly seen on the other. Can distance, orabso lute paucity account for this? Or is a veil of absorption interposed between us and the far side? If the latter, we must suppose the Magellanic cloud to consist of an equatorial zone of radiant objects, while from the poles extend to the equator masses of gaseous compounds hitherto unexcited. We are at once led to speculate whether, in the case of our universe, the same may not be the case. If so, then the innumerable "white" nebulæ, capping the galactic poles, are spots where energy is active in the vast mass. The continuous spectrum is due to that activity, and the absorption lines to the medium the light passes through. Again, the cases of stars with a double spectrum may point to an absorbing medium, since obviously if a gaseous star is approaching or receding the bright lines will be found on one side or the other of the dark lines of absorption. The idea of a mysterious something, which seems to have been latent in the mind of Sir William Herschel, may be proved in the end to be true, and glorious as is the universe of stars, *βλέπομεν ἄρτι δι' ἐσόπτρου ἐν αἰνίγματι*,* and the mind shrinks from the contemplation of what it would appear were the absorption veil withdrawn.

* "Now we see through a glass, darkly."—I. Cor. xiii. 12.—EDITOR.

TOW LAW,
CO. DURHAM, ENGLAND
February 8, 1912.

THE SPECTROSCOPIC BINARY θ^2 TAURI*

By J. S. Plaskett

THE star θ^2 Tauri, R. A. $4^h\ 22^m{\cdot}9$, Dec. $+15°\ 39'$, Magnitude 3·62, Spectral Type A5, was announced as a spectroscopic binary by Moore in the *Lick Observatory Bulletin*, Vol. V., No. 62, and by Frost in the *Astrophysical Journal*, Vol. XXIX., page 238.

In the following table are given the published observations obtained at these observatories, with the date, Julian Day, phase and residual, the two latter being obtaind from the elements finally accepted.

Observatory	G. M. Date	Julian Day	Velocity	Phase	Residual O-C
Lick	Dec. 1· — 1903	2,416.450	+38	139·2	- 1·6
	Jan. 3· — 1905	6,849	+50	114·2	+ 15·8
	Oct. 4· — 1905	7,488	+74	50·8	- 9·3
	Sept. 8· — 1908	8,193	+80	53·3	- 5·4
	Oct. 21· — 1908	8,239	+17	99·3	- 13·5
	Oct. 25· — 1908	8,240	+23	100·3	- 9·3
Yerkes	Aug. 23·88, 1905	7,454	+42	16·88	- 4·8
	Nov. 4·77, 1907	7,884	+29?	25·27	- 21·8
	Aug. 25·94, 1908	8,179	+64	34·44	+ 2·8
	Sept. 8·95, 1908	8,193	+88+40	53·45	+ 2·6
	Sept. 18·85, 1908	8,203	+10	63·35	23·6
	Oct. 12·85, 1908	8,227	+39+ 8	87·35	+ 10·2
	Nov. 8·78, 1908	8,254	+30	114·28	+ 2·0
	Dec. 7·03, 1908	8,283	+38	2·03	- 3·6
	Dec. 11·63, 1908	8,287	+31	6·63	- 11·9

The star was placed under observation on December 11, 1909, and between that date and March 11, 1912, 66 plates were obtained, of which 52 were of sufficiently good quality to be measured. As mentioned above, the spectrum is of type A5, containing numerous metallic lines, which are all, however, rather wide and diffuse, making accurate measurements difficult, and the agreement between different lines on the same plate some-

* Read before Royal Society of Canada, May 14, 1912.

times very poor. There was some little uncertainty as to whether better results would be obtained with high or low dispersion, and of the 52 plates measured 5 were made with spectrograph III L, 10·1 Å., 11 with III S, 17·6 Å., 3 with III R, 20·2 Å., and 33 with I, 33·4 Å. per millimetre at H_γ.

A comparison of the residuals given in the table of measures shows that the average three-prism residual is about 20 per cent less than the single-prism, showing a slight advantage in favor of the higher dispersion. This is, however, mostly counteracted by the shorter time required for obtaining the plates and the greater ease of measurement on the lower dispersion plates, which were usually made on Seed 23 Emulsion. Three of the plates showed lines suspected of being double, but the measures resulting therefrom showed such poor internal agreement and the mean values were so far from any value required by theory for the companion as to render their reality very improbable. The latter condition is also true of two spectra reported as double by the Yerkes Observatory. Nevertheless some deviations of the normals from the final velocity curve would appear to point to some abnormal source of irregularity in the measures.

The principal lines measured are given in the accompanying list, with their wave-lengths and source.

LINES MEASURED IN 6^2 TAURI

Wave-Length	Element	Wave-Length	Element
4584·018	Fe	4455·116	Blend
4572·156	Ti	4415·293	Fe
4563·939	Ti	4404·927	Fe
4549·766	Ti-Fe	4399·935	Ti-Cr
4534·139	Ti	4395·201	Ti
4515·508	Ti	4374·520	Blend
4508·455	Ti	4351·930	Cr
4501·448	Ti	4340·834	H
4494·738	Fe	4325·939	Fe
4481·400	Mg.	4315·138	Fe
4468·663	Ti	4290·377	Ti

The summuary of measures and other data of the 52 plates used are given in the following table.

Summary of Measures

Plate No.	Date G.M.T.	Julian Day	Spectrograph	Phase	Velocity	Residual O-C
3030	Dec. 11·73 1909	8,952·73	III S	90·73	+ 28·2	− 1·2
3041	Dec. 16·74 1909	957·74	III S	95·74	30·9	+ 0·6
3044	Dec. 18·66 1909	959·66	III S	97·66	34·7	+ 3·9
3056	Dec. 28·78 1909	969·78	III S	107 78	34·9	+ 2·2
3068	Dec. 30·51 1909	971·51	III S	111·51	22·8	− 10·3
3076	Dec. 30·65 1909	971·65	I	111·65	22·1	− 11·1
3085	Jan. 7·52 1910	979·52	III S	117·52	31·4	− 3·6
3108	Jan. 14·66 1910	986·66	III S	124·66	29·2	− 7·3
3118	Jan. 15·53 1910	987·53	III S	125·53	38·9	+ 2·1
3133	Jan. 19·50 1910	991·50	III S	129·56	37·4	0·3
3169	Feb. 3·70 1910	706·70	III S	4·20	40·0	+ 3·9
3201	Feb. 21·55 1910	724·55	I	22·05	42·6	− 6·4
3208	Feb. 23·55 1910	726·55	I	24·05	57·0	+ 7·3
3222	Feb. 24·56 1910	727·56	III S	25·06	40·7	− 3·8
3255	Mar. 2·63 1910	733·63	I	31·13	60·6	+ 6·3
3268	Mar. 3·59 1910	734·59	III R	32·09	54·0	1·0
3308	Mar. 10·61 1910	741·61	III R	39·11	58·6	− 2·6
3334	Mar. 17·55 1910	748·55	III R	46·05	71·8	− 0·5
3623	Sept. 7·89 1910	922·89	I	79·69	31·9	+ 4·4
3651	Sept. 14·86 1910	929·86	I	86·86	37·3	+ 8·6
3658	Sept. 15 87 1910	930·87	I	87·87	42·5	+ 13·6
3668	Sept. 16·79 1910	931·79	I	88·79	27·3	− 1·7
3687	Sept. 21 88 1910	936·88	I	93·88	30·0	+ 6·0
3730	Oct. 10·90 1910	955·90	I	112·90	25·8	− 8·1
3741	Oct. 12·88 1910	957·80	I	114·88	37·6	+ 3·4
3784	Oct. 31·73 1910	976·73	I	133·73	38·7	0·2
3793	Nov. 2 82 1910	978·82	I	135·82	37·7	1·7
3802	Nov. 8·81 1910	984·81	I	1·31	44·3	+ 3·1
3818	Dec. 5·67 1910	9,011·67	I	28·17	56 7	+ 4·3
3843	Dec. 9·67 1910	015·67	I	32·17	56·2	+ 1·2
3859	Dec. 12·60 1910	018·60	I	35·10	61·2	+ 3 9
3871	Dec. 15·65 1910	021·65	I	38·15	55·1	5·1
3888	Dec. 21·66 1910	027·66	I	44·16	67·0	1·1
3916	Jan. 5·57 1911	042·57	I	59·07	40·1	− 10·4
3922	Jan. 9·61 1911	046·61	I	63·11	27·0	− 7·0
3930	Jan. 12·61 1911	049·61	I	66·11	32·3	+ 3·1
3938	Jan. 16·67 1911	053·67	I	70·17	25·8	− 1·0
3958	Jan. 18·59 1911	055·59	I	72·09	28·0	+ 0·6
3973	Jan. 30·59 1911	067·59	III L	84·09	35·1	+ 6·9
4627	Oct. 10·79 1911	320·79	I	56·29	66·5	8·5
4636	Oct. 12·86 1911	322·86	I	58·36	64·9	− 1·1
4672	Oct. 28·75 1911	338·75	III L	74·25	26·9	− 0·3
4716	Dec. 6·77 1911	377·77	I	113·27	34·2	+ 0·2
4733	Dec. 19·82 1911	390·82	III L	126·32	26·7	10·3
4739	Dec. 25·75 1911	396·75	I	132·25	35·4	− 3·1
4760	Jan. 10·63 1912	412·63	III L	7·63	41·4	− 1·8
4780	Jan. 12·67 1912	414·67	I	9·67	45·3	+ 1·4
4788	Jan. 13·50 1912	415·50	III L	10·50	39·1	− 5·1
4792	Jan. 16·60 1912	418·60	I	13·60	40·7	− 4·7
4832	Feb. 10·66 1912	443·66	I	38·66	60·9	+ 0·1
4835	Feb. 12·65 1912	445·65	I	40·65	58·9	− 4·1
4880	Mar. 11·52 1912	473·52	I	68·52	25·8	− 2·5

It was early recognized that the period was somewhere in the neighborhood of 140 days, and a grouping of our own observations appeared to be best satisfied with a period of 141·0 days, although a somewhat shorter period would produce better agreement of the earlier observations with the Ottawa curve.

Nevertheless for the interest of the question, it was thought desirable to make a least squares solution for all the elements, including the period. For this purpose the 52 observations were grouped into 15 normal places so arranged that in any normal place not only was there no very great difference of phase, but in general also no great difference of epoch. This latter and the grouping of the observations was arranged to enable the correction to the period to be of as great weight as possible.

Preliminary elements obtained by the aid of Dr. King's* graphical method were as follows:

Eccentricity	$e = 0{\cdot}65$
Half Amplitude	$K = 25$ km.
Longitude of Apse	$\omega = 45°$
Velocity of System	$\gamma = +41{\cdot}51$ km.
Initial Epoch	$T_0 =$ J. D. 2,418,987
Periastron Passage	$T =$ J. D. 2,419,038·0
Period	$P = 141{\cdot}0$ days

Observation equations for the 15 normal places were formed according to Schlesinger's† method and from these observation equations normal equations were obtained in the usual way whose solution gives:

$\delta\gamma = +{\cdot}6535$	and	$\gamma = +42{\cdot}17$ km.
$\delta K = +1{\cdot}5891$	and	$K = 26{\cdot}589$ km.
$\delta\omega = +2°{\cdot}431$	and	$\omega = 47°{\cdot}431$
$\delta e = +{\cdot}0488$	and	$e = {\cdot}6988$
$\delta T = +{\cdot}0745$	and	$T = 51{\cdot}075$ days
$\delta\mu = -{\cdot}0001534$	and	$P = 141{\cdot}487$ days.

When an ephemeris was constructed from these corrected elements, although the agreement of the Ottawa observations

* *Astrophysical Journal*, Vol. XXVII., p. 125.

† *Publications Allegheny Observatory*, Vol. I., p. 33.

was slightly improved, the new period produced such high residuals with several of the early observations at the Lick and Yerkes Observatories as to be quite inadmissible, and the period was, therefore, determined by use of the early observations. The period giving the best agreement among all the observations was 140·50 days which was accepted as final. Using this period the Ottawa observations were now grouped into ten normal places as, when no correction for the period is required, some of the previous groups readily combined with one another. The new preliminary elements, determined by the same method as before, are :

$$e = 0{\cdot}65$$
$$\omega = 50^{\circ}$$
$$K' = 27{\cdot}0 \text{ km.}$$
$$\gamma = 42{\cdot}72 \text{ km.}$$
$$T = 56{\cdot}33 \text{ days} = 2{,}418{,}856{\cdot}33$$
$$T_0 = 2418{\cdot}800$$
$$P = 140{\cdot}50 \text{ days.}$$

Constructing an ephemeris, and obtaining observation and normal equations as before, we get the following solution :

$$\delta\gamma = +0{\cdot}88 \quad \text{and} \quad \gamma = +43{\cdot}60 \text{ km.}$$
$$\delta K' = +6{\cdot}76 \quad \text{and} \quad K' = 33{\cdot}76 \text{ km.}$$
$$\delta\omega = -10^{\circ}{\cdot}91 \quad \text{and} \quad \omega = 39^{\circ}{\cdot}09$$
$$\delta e = +{\cdot}1082 \quad \text{and} \quad e = {\cdot}7582$$
$$\delta T = -1{\cdot}454 \quad \text{and} \quad T = 54{\cdot}876 \text{ days,}$$

These corrections are so high that the second-order terms in the differential equations can no longer be neglected, and the corrections were considered to have overstepped the amount, to have gone too far in the increase of K' and e. Consequently new preliminaries were adopted as a compromise.

$$e = 0{\cdot}70$$
$$\omega = 45^{\circ}$$
$$K' = 32$$
$$\gamma = +43{\cdot}16$$
$$T = 55{\cdot}74.$$

The difficulty seemed to lie chiefly in the fact that there are no observations at the maximum velocity in the orbit, at the peak of the velocity curve, to limit its upward climb, a tendency which the accidental errors of the other observations seemed to favor. Consequently the previous observations at the Lick and Yerkes Observatories were re-examined to see if any help could be obtained from them. It was at once seen that on the same night, September 8, 1908, observations at the peak of the curve, at the phase 53·45 days, were made at each observatory, the measured velocity at the Lick being + 80 km., at the Yerkes + 88. The mean of these two was used as an additional normal place of weight ¼.

From the above compromise preliminary elements, another least squares solution was carried through, giving the following values for the unknowns and for the final elements.

$$\delta\,\gamma = -\ \cdot 264 \text{ km.}$$
$$\delta\,K = -\ 2\cdot 872 \text{ km.}$$
$$\delta\,\omega = +\ 3^\circ\cdot 573$$
$$\delta\,e = -\ \cdot 00595.$$
$$\delta\,T = +\ \cdot 384 \text{ days.}$$

Final Elements	Elements from first ten observation equations
$\gamma = +\ 42\cdot 90$	+ 43·71 km.
$K = 29\cdot 128$	37·99 km.
$\omega = 48^\circ\cdot 573$	38°·22
$e = 0\cdot 694$	0·7717
$T = 56\cdot 124$	55·207 days.

That the final elements given above are satisfactory was evident when the residuals obtained from the final elements and from substitution in the observation equations were compared. The differences between ephemeris and equation were, except in one case, (No. 8), less than 0·2 km., which, considering the quality of the spectrum, is sufficiently good to show that little would be gained by carrying through another solution. That

the addition of normal place No. 11 was necessary is indicated from the values obtained by a solution from the first ten observation equations given in the last column above. It will be seen that the eccentricity and half-amplitude are even greater than those obtained from the second solution and are such that the maximum positive velocity reaches 105 km., which, however good the agreement in the other part of the curve, is quite inadmissible in view of the observations at Mt. Hamilton and Williams Bay. Although the accuracy of the observations does not, perhaps, justify the amount of labor involved in the numerous solutions, the latter, nevertheless, are of interest and value in showing, if a satisfactory orbit is to be obtained, the necessity of having a fairly homogeneous set of observations. This seems to be especially true where a sharp maximum, as in this curve, occurs. If observations are lacking at the maximum, many quite different sets of elements, apparently suiting the remainder of the observations almost equally well, can be secured and the true one can only be definitely determined from observations at this point. A further point of interest, which although previously recognized, has been clearly brought out by these solutions, namely, the greater value, in the determination of the period, of early observations than of a least squares correction, especially where the character of the spectrum is such as to prevent very accurate observations.

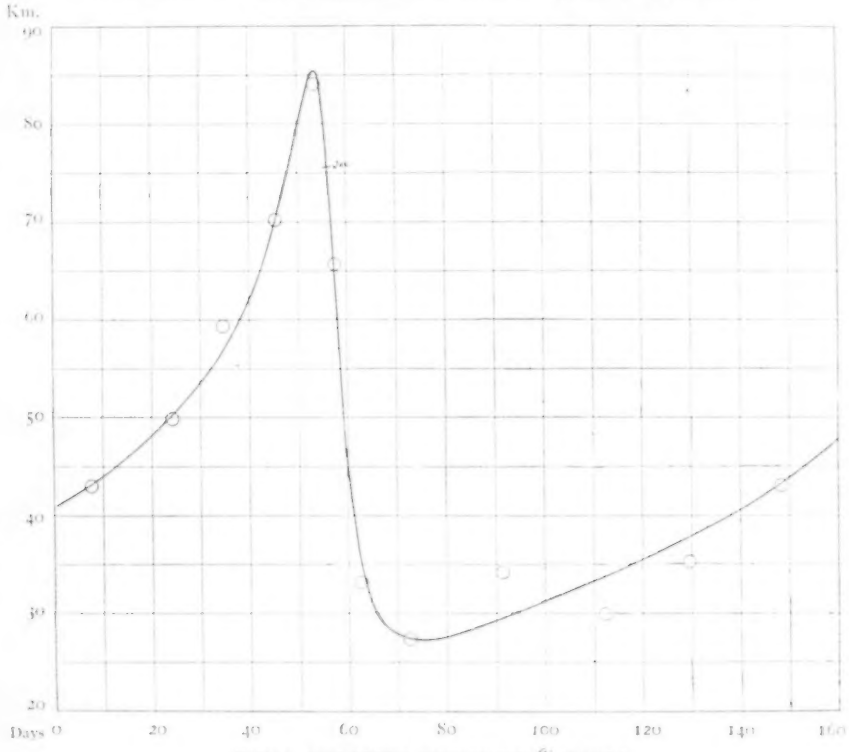
For convenience of comparison the different sets of elements obtained are tabulated below.

Element	1st Preliminary	1st Solution	2nd Preliminary	2nd Solution	3rd Preliminary	3rd Solution	Final Solution
Period	141·0	141·487	140·50	140·50	140·50	140·50	140·50
e	0·65	0·699	0·65	0·758	0·70	0·772	0·694
K	25·0	26·589	27·0	33·76	32·0	37·93	29·128
ω	45°·0	47°·43	50°·0	39°·09	45°·0	38°·22	48°·573
T	51·0	51·075	56·33	54·876	55·74	55·207	56·124
γ	+41·51	42·17	42·72	43·60	43·16	43·713	42·90
Max. Vel.	+78	+81·34	+81	+97·22	+91·0	+104·7	+85·40
Min. Vel.	+28	+28·16	+27	+29·70	+27·0	+28·7	+27·14
$a \sin i$							40,497,000
Σpvv	66·20	48·90	+58·61	90·18	63·83		47·84

The residuals from the individual plates obtained by careful scaling from the final velocity curve, which is shown in the figure, are given in the last columns of the summary of measures. The probable errors of a single average plate obtained from these residuals and from those of the Lick and Yerkes plates are:

Ottawa = ± 3·56 km.
Lick = ± 7·53 km.
Yerkes = ± 8·60 km.

Considering the quality of the lines for measurement, the Ottawa probable error is quite satisfactory, but the high values for Lick and Yerkes plates and the curious apparently systematic



FINAL VELOCITY CURVE OF θ^2 TAURI

irregularity in the observations and normal places around phase 100 indicate something abnormal in the orbit. As mentioned previously, this cannot apparently be ascribed to the presence of the spectrum of the companion body and must for the present be left unsolved. It is proposed later to obtain some more plates at the phase of maximum velocity as further tests for the presence of a second spectrum and for the position and magnitude of the maximum.

The star θ^2 Tauri is of special interest as being one of the moving stream in Taurus described and discussed by Professor Boss.* His computed radial velocity for θ^2 Tauri is + 40·5 km. which is 2·2 km. less than the velocity obtained from the Ottawa plates. His velocity is based on Küstner's determination of the radial motions of three other stars of the group. In a later discussion of the Taurus stream by Wilson†, in which the computed values are based on the radial velocities of eight stars of the stream determined by Campbell, the velocity of θ^2 Tauri is + 39·2 which is 3·5 km. less than the Ottawa value. There is no doubt, therefore, that the latter is about 3 km. too great, a further indication of something abnormal, for there is no question that the Ottawa observations will not give a lower value than + 42 km. If Boss's value of the proper motion and of the distance of the convergent be accepted, the value of the parallax of θ^2 Tauri is 0″·023 equivalent to a light journey of about 140 years.

I have much pleasure in acknowledging the interest taken by the Director, Dr. King, in this work.

* *Astronomical Journal*, Vol. XXVI., p. 31.
† *Popular Astronomy*, Vol. XX., p. 359.

DOMINION OBSERVATORY,
OTTAWA, CANADA.
May 1912.

IN THE BACKGROUND OF THE STARS*

By C. A. Chant

IN astronomy, as in every other study, the deeper one dips below the surface the more interesting it becomes. When we look into the sky on a clear dark night, the numerous stars in their various magnitudes and mystic groups arouse in us the profoundest speculations. There is enough in a naked-eye study of the heavens to provide thought for many days. But with the slight optical assistance of an opera glass or a small telescope new wonders come to view, while the modern great telescope, the spectroscope and the photographic plate reveal secrets which, a hundred years ago, it was thought we could not possibly learn.

Astronomy is indeed greatly indebted to photography, and in no way has this indebtedness been rendered more evident than in exhibiting the extraordinary forms and the delicate beauty of those faint, filmy objects known as nebulæ. These bodies in many instances are so faint that their light cannot directly affect the eye, even though it be assisted by a large telescope; but the sensitive photographic plate, drinking in the weak illumination for several hours together, at last accumulates a record which is made permanent by the familiar process of developing and fixing in the dark room.

The nebulæ appear to be just in the background of the stars. In many instances we have good reason to believe that some stars are actually surrounded by nebulæ, and that the nebulous matter is condensing to form them into suns like our own. Indeed, some photographs show that extensive portions of the sky are simply filled with the gauzy nebulous substance. A good illustration of this is shown in Figure 1, which is from a

* Reprinted, with slight alterations, from *The Westminster*, (Toronto), for November, 1911.

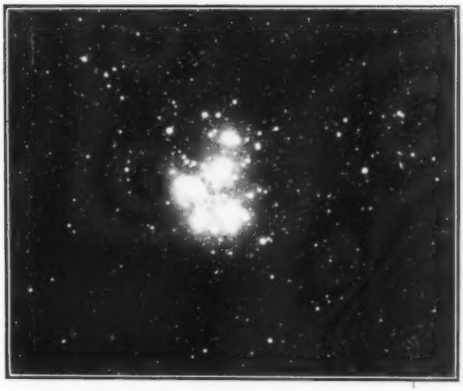


FIGURE 1.

THE PLEIADES

Photographed with an exposure of 5 hours. Notice that the entire group is surrounded by nebulous matter.

FIGURE 3.

SIR JOHN HERSCHEL'S DRAWING OF THE GREAT NEBULA IN ANDROMEDA.

The dot at the right hand lower corner represents the solar system on the same scale.

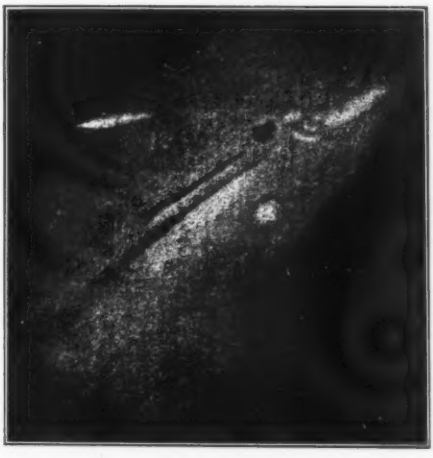


FIGURE 4

BOND'S DRAWING

Using the 15-inch Harvard Telescope, 1848.

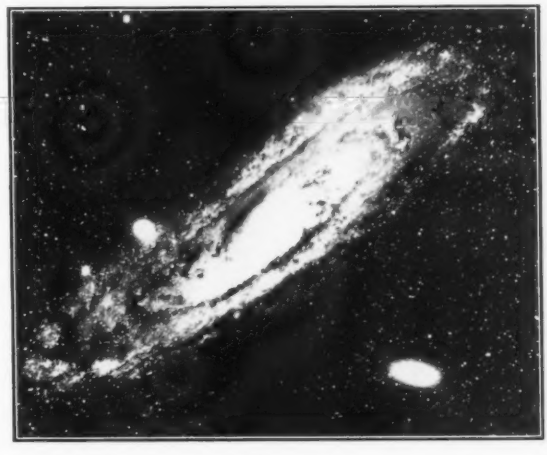


FIGURE 5

THE GREAT NEBULA IN ANDROMEDA

From a photograph taken at the Yerkes Observatory with a 24-inch reflecting telescope.

photograph obtained with an exposure of five hours. All the chief stars of this famous group, the Pleiades, are enmeshed in the nebulous matter.

There is only one nebula in the sky which is certainly recognisable as such by the unaided eye. It is in the constellation Andromeda, and as there is a real pleasure in being able to identify an object like this, I shall explain a convenient way to locate it.

I hope that those who read this will not have forgotten that the stars cross the sky from east to west just as the sun and the moon do. This is caused by the rotation of the earth on

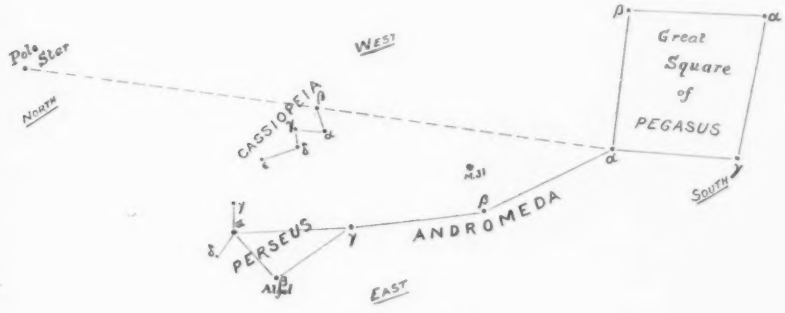


FIGURE 2.

How to locate the Great Nebula in Andromeda, technically known as M. 31.

its axis. Also remember that the stars change with the seasons. This is produced by the yearly revolution of the earth about the sun. Now Andromeda is almost directly overhead at midnight on October 1, at 10 p.m. on November 1, and at 9 p.m. on November 15.

Of course every one can identify the Pole Star, and the constellation Cassiopeia will also be recognised at once. Its chief stars form a sprawling W, and in the autumn it is seen above the Pole Star, on the opposite side from the Big Dipper. That star in the W which is farthest to the west is called Beta of Cassiopeia.

Now, beginning at the Pole Star, draw a line through Beta of Cassiopeia, and continue it about an equal distance It will reach a bright star, of the second magnitude, known as Alpha of Andromeda. The line so drawn almost coincides with the equinoctial colure, "the first meridian of the sky," which is used as a reference line for locating objects in the sky, just as the meridian through Greenwich is used on the earth. This star, with two others almost equally bright and nearly in a straight line, are the chief stars in the constellation Andromeda. The middle one of the three is called Beta, the other one Gamma (See Figure 2). Notice also that the star Alpha of Andromeda, with Alpha, Beta and Gamma of Pegasus, form the Great Square of Pegasus. All these features are prominent and will be easily identified.

Now return to Beta of Andromeda and run a little to the north and west of it (about 8 degrees), and you will reach the Great Nebula. It appears like a star seen through a haze, and you may have to look for a while before recognising it. If an opera glass is convenient use it, and you will then have no doubt about the nebula. It will appear like a slightly oval hazy patch of light.

The first recorded observation of this object is by Simon Marius, a German, in 1612. Galileo invented his telescope in 1610, and Marius was one of the first to apply it to astronomical observations. In the centre of the nebula he observed a condensation of light, which he compared to "the flame of a candle seen through a leaf of transparent horn."

It is interesting to compare some of the drawings of this object with pictures obtained by photography.

In Figure 3 is reproduced a drawing of it made by Sir John Herschel, with the assistance of a powerful reflecting telescope. His description is as follows: "Its form, as seen through ordinary telescopes, is a pretty long oval, increasing by insensible gradations of brightness, at first very gradually but at last more rapidly, up to a central point, which though very much brighter than the rest, is decidedly not a star."

FIGURE 6.

THE GREAT NEBULA IN ORION.

From Bond's Drawing, published in the Harvard College Observatory *Annals*.

In 1848, G. P. Bond, after a prolonged study with the 15-inch refracting telescope of the Harvard College Observatory, published the drawing which is reproduced in Figure 4. From this time opinion was divided as to whether the nebula was of a regular oval shape or of an irregular form, until a very decisive answer came by photography in 1888. Isaac Roberts, after a successful career as contractor and builder in Liverpool, retired and devoted himself to astronomy. He secured the construction of a high-grade reflecting telescope of diameter 20 inches and began the photography of faint objects such as nebulæ and star clusters. One of his earliest and greatest results was a photograph of the Andromeda nebula, which settled the question as to its form forever. Figure 5 is from a photograph made at the Yerkes Observatory with a 24-inch reflector constructed by Ritchey. It is very similar to Roberts' picture. A close examination shows that the nebula is really spiral in structure, being seen by us partly on edge.

There is only one other nebula which can be considered in the same class as that just described. It is in the constellation Orion, being a little below the three well-known stars which form the Belt of the Giant. It would hardly be recognised as a nebula by the naked eye, but an opera glass easily reveals its nature. As a rule, nebulæ are not striking objects in the telescope, but this one is an exception. Even in a small instrument it is wonderful, though it lacks much of the beauty shown by a larger one.

Great patience and care have been expended by skilful astronomers in drawing this object, and, it must be acknowledged, with considerable success. But the results cannot be compared with those obtained by photography. Bond spent over one hundred hours in carefully drawing the nebula, while an exposure of half-an-hour in a good reflector will exhibit a wealth of detail with an accuracy not approached by any drawing. Figure 6 is from a reproduction of Bond's famous drawing, while Figure 7 is from a photograph taken by Ritchey at the Yerkes Observatory with a 24-inch reflector.

This is an excellent example of a nebula without any regular form. On the other hand, Figure 8 shows one of a very definite form. There is no question about it being a spiral; but although this is clear enough in the photograph, on account of its extreme faintness it would scarcely by recognised as such in a telescope. One can not look at this picture without feeling almost certain that the nebula is in motion. Those arms are surely revolving about the central condensation. However, we have no unquestionable evidence of any such motion. Our trustworthy photographs of these objects have not been taken at times wide enough apart for us to recognise any change in the interval. One of the most interesting cases of a suspected change is illustrated in Figure 9, in which is reprodnced a drawing made with Lord Rosse's great 6-foot reflector in 1848, and also a Lick Observatory photograph taken fifty years later. The change exhibited is too great to be attributed to faulty drawing, but it may have been produced by the motion of the star from the eye of the "Owl" rather than by any change in the nebula itself.

There are many interesting questions regarding nebulæ, but I can refer to only two.

How many nebulæ are there? Charles Messier was a French astronomer who spent most of his time hunting for comets. Now the ordinary comet closely resembles a nebula, and in order to avoid confusion of the two kinds of bodies, Messier made a list of nebulæ. It was published in 1781 and contained 103 entries. In this list the Great Nebula in Andromeda is numbered 31, that in Orion is 42, and the "Owl" is 97. Sir William Herschel by 1802 had discovered 2,500 more, and in 1864 Sir John Herschel, his son, made a catalogue of all then known, amounting to 5,079. Dreyer's catalogue, compiled in 1887 and added to in 1894, contains 9,369 nebulæ, of which more than half were discovered by the two Herschels. Quite recently Perrine, from photographs of representative portions of the sky, taken at the Lick Observatory by Keeler and himself, has

FIGURE 7.

THE GREAT NEBULA IN ORION.

From a photograph by Ritchey at the Yerkes Observatory.

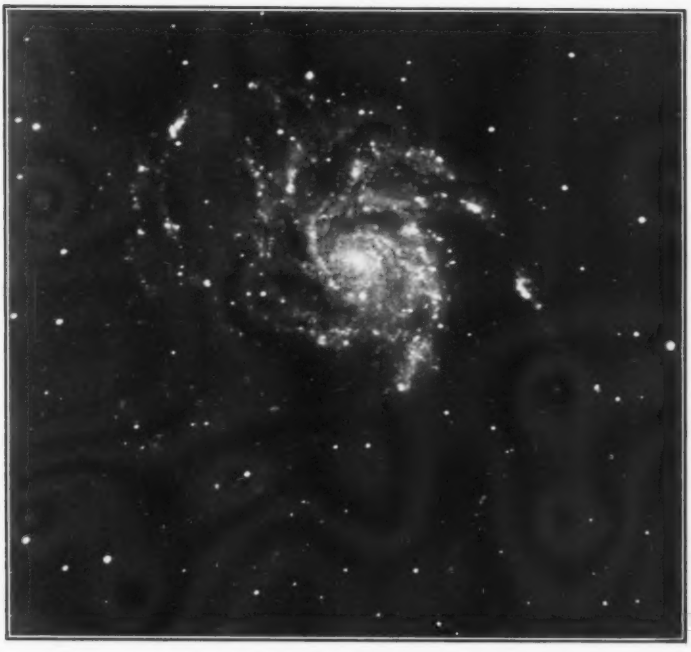


FIGURE 8.

A SPIRAL NEBULA IN THE GREAT BEAR.

From a photograph taken at the Lick Observatory. Exposure 4 hours.

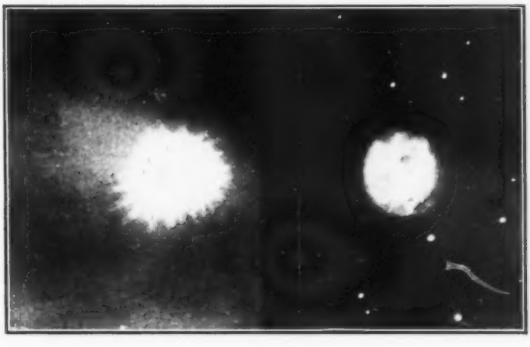


FIGURE 9.

A DRAWING OF THE "OWL" NEBULA

Made with Lord Rosse's 6-foot reflector in 1848, and a photograph taken at the Lick Observatory in 1898.

estimated the number in the entire sky to be not less than 500,000.

What are the nebulæ composed of? For many years it was thought that they were simply clusters of stars closely packed together, and that all that was required to exhibit the individual stars was a sufficiently powerful telescope. The spectroscope has demonstrated that this view was erroneous. We know with absolute certainty that some are simply masses of luminous gas. The Orion nebula is one of these, but that in Andromeda seems quite different. Our best observations go to show that the latter is probably composed of stars, and it has been surmised that it is similar to our Milky Way, but so distant that it appears like a nebula. For some time it was thought that the irregular nebulæ were gaseous in nature and that the regular ones were aggregations of stars; but that has been proved incorrect. No simple law like this can be enunciated. The more we learn of these strange bodies the more complicated is the problem of their nature.

METTINGS OF THE SOCIETY

At Toronto.

Tuesday, June 4.—An Open Air Meeting was held on the lawn of the Observatory. Several telescopes were placed at the disposal of the members and their friends. By the courtesy of the Director, Mr. Stupart, the large telescope in the tower was made available, under the direction of Mr. Blake.

Friends and visitors to the number of over a hundred, as well as many of the members, availed themselves of the opportunity of viewing the planets Mars and Jupiter through the telescopes as well as many of the stellar objects in the various constellations that were well placed for observation.

The objects viewed included the Hercules Cluster, the Ring Nebula in Lyra, the Double Double in Lyra, Nebula in Ursa Major, Coma Berenicis, Canes Venatici, Virgo and Ophiuchus, and the double stars β Cygni, Cor Caroli, ϵ Bootes and α Hercules.

L. G.

At Peterborough (Midsummer Meeting)

The Annual "At-Home" of the Peterborough Centre of the Society was held on the evening of July 23rd, at the residence of the President, Homer O. Fiske, McDonnel Street, who kindly placed his grounds at the disposal of the Society. The lawn was beautifully illuminated with colored electric lights, presenting a gay and charming appearance.

Mr. and Mrs. Fiske received the guests, assisted by Lt.-Col.

and Mrs. Miller, Mr. and Mrs. F. S. Schneider, and the Misses Miller.

The large telescope of the Society, and the fine intruments presented by the Hon. J. R. Stratton, were placed in position on the lawn to give those present an opportunity of viewing a number of celestial objects of interest.

After spending an hour on the lawn, an informal meeting of the Society was held, with Dr. Marsh, the secretary, in the chair, Mr. Fiske as President, being host of the evening.

Miss Florence Scott, Mr. J. H. Burnham, M.P., Mr. W. A. Logan, Mr. D. Easson, Mr. F. H. Dobbin, Dr. Eastwood and Mr. Wm. Madill contributed to the programme of the evening.

Mr. Fiske's connection with the Society and the many services he had rendered from time to time were appreciatively referred to. His services, always available at the lectures, his lantern slides, and attention to such matters have done much to encourage the study of astronomy in Peterborough.

After the conclusion of the programme, the guests partook of refreshments, the number of those availing themselves of the opportunity to be present taxed the capacity of the residence and adjoining grounds. The thanks of the Society were tendered Mr. and Mrs. Fiske for a very enjoyable evening.

At Regina

February 1, 1912. —The meeting was held in the auditorium of the Collegiate Institute this evening. Professor G. H. Ling Ph.D., University of Saskatchewan, gave a very able and interesting address on "Planetary Atmospheres."

Mr. Hector Lang, President of Regina Centre, presided and while there was a goodly number of the menbers of the society present, yet the audience was not as large as usual.

In the course of his address the lecturer outlined the molecular theory of matter and gradually introduced a discussion of such questions as: — Can a molecule of matter leave the earth? If so, will the earth ever lose its gaseous covering? The two theories, as advanced by the two great schools of thought on

this question, the one as presented by Dr. Johnstone Stoney, supported by Sir William Ramsay, and the other by Drs. Cook, Jean and Bryant, were then ably presented and discussed. These schools are divided on the question as to whether or not gaseous matter does leave the earth. Dr. Stoney argues that certain of the lighter gases, such as helium do disappear from the earth, but that the heavier gaseous matter, such as water vapor, etc, does not.

The dynamical question as to what would constitute the critical velocities of the molecules of the gases upon the various planets was then introduced, and some very interesting results —as secured by Dr. Stoney in his researches, were advanced.

Dr. Ling then pointed out that, according to Dr. Stoney, the moon can have no atmosphere; Mercury, Venus and Mars would have the heavier gases predominating; Saturn, Uranus and Neptune would have practically all the gases, excepting the lighter ones; while Jupiter would have all the gases known to exist in its atmosphere. It was then explained that the results of Dr. Stoney's investigations were largely substantiated by the results of spectrum analysis.

The lecture was full of suggestion and food for contemplation, while the discussion at the close of the address showed the very close attention and keen interest with which the audience followed and appreciated it. All were impressed with the idea of careful thought, vigorous inquiry and painstaking research on the part of our astronomers in there endeavors to solve the many mysteries of this wonderful universe.

At the close of the address a hearty vote of thanks was tendered to the lecturer and the meeting adjourned to make some observations of Saturn. Some particularly fine views were to be had of Saturn and the Orion nebula.

March 14.—An unusually interested audience listened to Magistrate Trant's address on "The Pendulum" this evening in the Collegiate Institute. Mr. Hector Lang presided.

Mr Trant began his lecture on "The Pendulum" by reference to the well known incident of Galileo noticing a hanging-

lamp at Pisa in 1583. The afterwards famous man observed that, however the lamp swung, describing a comparatively big arc or a little one, all the oscillations were performed in equal times. At that period Galileo was neither a mathematician nor an astronomer, and it was this incident that stimulated him to become both. The lecturer then propounded and demonstrated the properties of the Pendulum by means of illustrations on the black-board. He then proceeded to show the wonderful things the Pendulum had done for the benefit of mankind.

The diurnal rotation of the earth, he said, had been believed in for centuries, but it was not demonstrated until as recently as 1851. In that year Foucault suspended a Pendulum 200 feet long from the ceiling of the Pantheon at Paris. On the bob was a stylus that traced in fine sand the movements of the Pendulum. It was found that the oscillating Pendulum never retraced its path, but deviated to one side at each oscillation and the amounts of the deviations were equal in equal times. This showed that the floor of the Pantheon, that is, the earth, was moving. The experiment has since been repeated in many parts of the globe. Mr. Trant then showed that the time of oscillation depends on the length of the Pendulum and the pull by gravity towards the centre of the earth. If, therefore, the earth were a perfect sphere a seconds Pendulum would be of the same length all over the globe. The Pendulum revealed however, that while the same Pendulum would beat seconds along the latitude of Regina, a longer one would be required to beat seconds at Dawson City and a shorter one to beat seconds at the equator, these places being at different distances from the centre of the earth. Experiments were conducted all over the world and thus the Pendulum discovered that the earth was a spheroid and also enabled the amount of its spheroidicity to be calculated. So delicate a recorder is the Pendulum that it is affected by the semi-diurnal flow of the tides. The Pendulum, said the speaker, does much more than this. By noticing the pull on the Pendulum by a mountain, and by noticing the effect upon

it by the different strata in the shaft of a deep mine, the density of the earth was estimated.

Mr. Trant then indicated different applications of the Pendulum to useful purposes. Amongst these was, of course, the clock. The simple instrument had also been used to correct the standards of length in different countries, such as the yard, the metre and so on. An interesting appliance was the ballistic pendulum, which, witha bob seven tons in weight, recorded the speed of projectiles from cannon or rifle. Pendulums also formed a principal part of seismometers for registering earthquake shocks. Indeed so many and varied were the uses of the modern instrument that from investigating the shape of the earth to ascertaining the elasticity of golf balls, it played the leading part.

Mr. Trant in conclusion claimed for the Pendulum a place by the side of the telescope and the spectroscope. It was the simplest of all instruments, merely a string with a bob at one end, yet it demonstrated the diurnal rotation of the earth, it discovered its shape and density, it calculated the speed of projectiles, regulated our clocks and it was used in a thousand ways reaching even to ornaments and toys.

A. J. P.

NOTES FROM THE METEOROLOGICAL SERVICE

JUNE

Temperature.— Mean temperatures were, roughly, above normal from the Pacific Coast to Lake Superior, and lower than normal from Algoma to the Atlantic Coast. The maximum positive differences from normal temperature occurred in southern Alberta and Northern Saskatchewan, amounting to about 7°. The greatest negative differences occurred in the Valleys of the Ottawa and Saguenay Rivers, and were slightly less than 5°.

Where frost was recorded in the Western Provinces it was light while the highest temperatures of the month in several instances exceeded 100°.

Precipitation.—The amount of precipitation during the month of June was about one inch less than the normal throughout the Dominion. Exceptions were noted in Lower British Columbia, at Calgary and Prince Albert.

JULY

Temperature.—Throughout the Western Provinces the mean daily temperature was lower than the normal ; by from 3° to 4° in Alberta and Saskatchewan, and 0·5° to 2° in Manitoba. On Vancouver Island and at the mouth of the Fraser the temperature was a little higher than normal, but elsewhere in British Columbia was from 1° to 4° lower. In Ontario the differences varied slightly above and below normal. There was a positive difference of less than 2° over the greater part of Quebec which was not sustained in the Gulf districts. In the Maritime Provinces the average variation from normal was negative and less than 1°.

Precipitation.—Except locally on Vancouver Island and locally in the Valley of the South Saskatchewan River, precipitation was between one and three inches in excess of the normal amount, from the Pacific Coast to the Lake of the Woods. From that point eastward, except in the southwestern counties of Ontario, to Father Point there was a deficiency of more than one inch. In the Gulf districts and in the Maritime Provinces, generally, there was an excess which ranged between one and five inches.

Temperatures for June and July, 1912

Station	June		July	
	Highest	Lowest	Highest	Lowest
Yukon				
Dawson	79·0	31·0	75·0	36·0
British Columbia				
Atlin	67·5	29·5	72·0	35·0
Agassiz	89·0	35·0	89·0	43·0
Barkerville	82·0	28·0	76·0	35·0
Kamloops	101	41·0	90·0	48·0
New Westminster	90·0	40·2	90·4	47·7
Prince Rupert	68·0	38·0	80·0	46·0
Vancouver	84·2	42·7	85·1	47·6
Victoria	89·5	41·2	89·8	45·5
Western Provinces				
Battleford	98·0	33·0	81·0	40·0
Broadview				
Calgary	90·0	29·0	79·0	33·0
Carman				
Edmonton	89·0	32·5	82·0	35·0
Medicine Hat	102	34·5	94·0	38·9
Minnedosa	98·0	33·5	92·0	35·5
Moose Jaw	96·0	31·0	83·0	42·0
Oakbank	93·0	34·0	85·0	38·3
Portage la Prairie	97·0	33·0	85·0	40·0
Prince Albert	95·5	35·5	79·2	40·5
Qu'Appelle	92·5	30·0	82·0	40·0
Regina	95·0	30·0	82·0	39·0
Swift Current	97·0	33·0	86·0	41·0
Winnipeg	98·2	33·3	89·3	42·0
Ontario				
Agincourt	86·9	34·5	92·7	43·1
Aurora			92·0	40·0
Bancroft	87·0	31·0	91·0	38·0
Barrie				
Beatrice	81·0	34·0	90·0	39·0
Birnam	85·5	35·0	89·1	40·0
Bloomfield	82·0	39·0	92·0	44·0
Brantford	90·0	35·0	94·0	46·0
Bruce Mines	86·0	33·0	88·0	36·0
Chatham	92·0	38·0	91·0	48·0
Clinton	85·0	34·0	90·0	42·0
Cottam	92·0	34·0	97·0	45·0
Gravenhurst	84·0	30·0	92·0	30·0
Guelph	85·0	35·0	88·5	44·0
Haliburton	89·0	30·0	95·0	36·0
Hamilton	92·0	41·0	92·0	45·0
Huntsville	83·0	33·0	92·0	40·0
Kenora				
Kinmount	83·0	29·0	90·0	41·0
Kingston	80·3	38·4	85·2	45·4
Lakefield	83·0	39·0		
London	90·5	33·0	92·5	40·5
Lucknow	84·0	33·0	89·9	40·1
Madoc	85·0	36·0	93·0	40·0
Midland	85·0	45·0	93·0	55·0
North Gower	90·0	32·0	96·0	40·0
Otonabee				
Ottawa	84·0	39·0	91·0	47·0
Owen Sound				
Paris	89·0	37·0	94·0	42·0
Parry Sound	84·0	37·0	95·0	45·0
Peterboro'	86·0	37·0	91·0	40·0
Port Arthur	86·0	34·0	79·0	40·0
Port Burwell	83·0	35·0	84·0	45·0
Port Dover	89·5	34·5	87·5	45·5
Port Stanley	88·2	34·6	86·2	45·8
Ronville	82·0	32·0	89·0	42·0
Sarnia				
Southampton	82·0	36·1	85·4	44·3
Stonecliffe	88·0	30·0	90·0	40·0
Stony Creek	90·0	38·0	93·0	40·0
Stratford	86·0	33·5		
Toronto	88·7	37·0	92·0	46·0
Uxbridge	84·0	33·0	90·0	41·0
Wallaceburg	90·0	37·0	89·0	47·0
Welland	85·0	35·0	91·0	46·0
White River				
Quebec				
Brome	82·0	30·0	90·0	39·0
Father Point	73·0	34·0	83·0	39·6
Montreal	83·2	39·4	92·4	52·4
Quebec	83·2	34·2	93·6	47·2
Sherbrooke	84·8	31·4	92·9	39·5
Maritime Provinces				
Charlottetown	84·0	37·0	91·0	42·0
Chatham	93·0	37·0	98·0	42·0
Dalhousie	81·0	34·0	94·0	44·0
Fredericton	90·0	35·0	95·8	41·5
Halifax	87·1	37·8	98·7	40·4
Moncton	90·0	34·0	95·0	22·0
St. John	76·3	39·8	77·5	45·0
St. Stephen	91·0	30·0		
Sussex	86·0	33·0	92·5	36·5
Sydney	86·0	33·0	91·5	40·0
Yarmouth	73·0	38·1	78·0	45·5

MAGNETIC OBSERVATIONS

June 2nd, 7th, 8th, 9th, 27th, and July 4th, 5th, 6th, 7th, 26th and 31st were disturbed days calling for no special comment.

Declination

Month	Mean of Month	Max.	Date	Min.	Date	Monthly Range	Amplitudes—Mean Daily	
							From hourly readings	From Means of Extremes
1912	° ′	° ′		° ′		° ′	′	′
June	6 13·5	6 23·7	10	5 52·1	8	0 31·6	10·6	14·4
July	6 13·5	6 23·6	31	5 55·6	4	0 28·0	11·5	13·9

Bifilar—C.G.S. Units

June	·16188	·16244	7	·16143	28	·00101	·00032	·00040
July	·16183	·16240	3	·16125	4	·00124	·00035	·00052

Inclination

Month	Mean Dover No. 209	Mean Earth Inductor
	° ′	° ′
June	74 39·2	74 39·1
July	74 39·1	74 39·2

Earthquake Records by the Milne Seismograph

TORONTO

R. F. Stupart, Director.

P.T. = Preliminary Tremors. L.W. = Large Waves. Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1912	P.T Comm.	L.W. Comm.	Max.	End.	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm	h m	
1097	June 3	0 14·2		0 14·6	0 20·8	0·2	0 6·6	Marked thickenings.
1098	" 3	12 39·4			12 40·4	0·05	0 1·0	Doubtful as to being seismic.
1099	" 3	12 51·9		13 28·5	14 0·6	0·3	1 8·1	Prolonged thick'ings
				13 38·9		0·2		increasing at times.
1100	" 6	15 32·9			15 33·4	0·05	0 0·5	Momentary thick'ng
1101	" 6		16 34·8		17 52·0	0·05		" "
1102	" 6	18 45·6		0 0.5	18 47·6	0·05	0 2·0	" "
1103	" 6	21 37·3		0 0·5	21 38·1	0·05	0 0·8	" "
1104	" 6	21 46·7			21 47·2	0·05	0 0·5	" "
1105	" 6	22 21·7			22 23·7	0·05	0 2·0	" "
1106	" 6	22 49·0			22 49·3	0·05	0 0·3	
1107	" 7	0 47·5			0 48·5	0·05	0 1·0	
1108	" 7	4 3·8		4 5·8	4 48·7	0·2	0 44·9	Extended
1109	" 7	5 2·0		5 2·8	5 20·0	0·2	0 18·0	Extended
1110	" 7	5 41·0			6 22·0	0·1	0 41·0	Increasing at times.
1111	" 7	6 36·0			6 46·0	0·05	0 10·0	Increasing at times.
1112	" 7	6 54·6		7 41·7	8 09·0	0·3	0 14·4	Extended thick'ings
1113	" 7	8 28.0		8 28·9	8 56·0	0·2	0 28·0	Extended thick'ings increasing at times.
1114	" 7	9 16·0	9 20 1	9 23·0	9 48·0	0·4	0 32·0	Very small
1115	" 7	10 17·1	10 21·0	10 26·7	contin'd to next.	0·8	contin-ued	trace.
1116	" 7		11 00·1	11 04·1	12 13·0	0·6		by flatten'ng out of Two bulges followed
1117	" 7	12 24·1	12 49·5	12 51·5	14 14·0	0·8	1 42·9	May be part last dist.
1118	" 7	14 39·5	14 45·3	14 46·3	15 27·2	0·3	0 47·7	Marked thickenings.
1119	" 7	16 28·8			16 53·4	0·05	0 24·6	Minute thickenings at times.
1120	" 7	18 39·7	18 50·5	18 52·1	21 15·0	0·8	3 35·3	Small.
		18 45·5						
1121	" 7	21 30·2	Minute thickenings began and became more pronounced at following times culminating in a larger disturbance on the 8th at 7h 54m·9.					
1122	" 7		22 8·7			0·2		
1123	" 7		23 12·0			0·2		
1124	" 8		0 25·3			0·3		
1125	" 8		0 44·8			0·4		
1126	" 8		1 23·2			0·3		
1127	" 8		1 45·9			0·3		
1128	" 8	2 37·3	2 40·3	2 41·8		0·3		
1129	" 8		3 20·0	3 21·3	4 25·0	0·4		
1130	" 8	4 54·4	5 00·0			0·1		
1131	" 8		5 26·3			0·2		
1132	" 8		5 51·0			0·3		
1133	" 8		6 39·0	6 42·0		0·3		
1134	" 8		6 42·4			0·3		
1135	" 8		6 54·0	6 56·9		0·2		
1136	" 8		7 15·6	7 18·5	7 53·6	1·8		
1137	" 8		7 54·9	8 1·9	13 02·0	4·0		Began abruptly,
			8 01·4	8 3·2		5·0		boom fairly quiet 2
				8 5·7		8·0		min. before. Cigar shaped movement.

Alaskan Earthquakes

TORONTO.—(*Continued*).

No.	Date 1912	P. T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1138	June 8		13 6·2	13 12·0		0·05	0 5·8	
1139	" 8		13 15·0) 13 25 2)	13 27·6	16 01·0	1·8	2 54·8	Medium.
1140	" 9	5 19·1			5 20·8	0·1	0 7·7	
1141	" 9	7 21·0			7 27·2	0·1	0 6·2	
1142	" 9	8 8·2			8 10·1	0·05		
1143	" 9	8 45·7		8 50·8	9 4·0	0·3	0 18·3	Small.
1144	" 9	16 21·8			16 45·5	0·1	0 23·7	
1145	" 9	17 1·0			17 5·0	0·05	0 4·0	
1146	" 9	17 35·7	17 39·6	17 44·1	18 50·6	0·8	1 14·9	Small.
1147	" 9	22 3·9		22 7·5	22 27·5	0·3	0 23·6	
1148	" 9	22 35·0		22 39·8	23 17·5	0·3	0 42·5	
1149	" 10	11 59·4			12 0·5	0·05	0 1·1	
1150	" 10	12 19·4				0·05		
	A continuation of minute thickenings up to 13 h 48 m							
1151	" 10	13 48·2			13 49·1	0·05	0 0·9	
1152	" 10	14 25·8			14 26·8	0·05	0 1·6	
1153	" 10	16 15·5 V$_2$ 16 22·9	V$_4$ 16 27·7	16 36·8	18 30·5	6·0	2 15·0	Well defined dis.
1154	" 10	18 53·0			19 37·0	0·05	0 43·5	Slight thickenings.
1155	" 12	7 22·7 V$_2$ 7 28·2	7 30·3	7 32·8	8 12·3	0·8	0 49·6	Well defined.
1156	" 12	12 51·5	12 54 7	12 57·8 12 58·8	14 30·2	0·8	1 38·7	12 min. movements at intervals 12 to 12 46 taken as A.Ts.
1157	" 13	11 44·5				0·05		Doubtful as to being seismic.
	From 11 56 to 3 35·6 of 13th small movements at intervals.							
1158	" 17	11 34·3	11 52·6	11 58·7	12 49·1	0·5	1 14·8	Long durat. of P.T.
1159	" 18	3 54·1			4 1·0	0·1	0 15·9	
1160	" 18	12 13·7			14 20·7	0·2	2 7·0	Prolonged thick'ings
1161	" 27	19 53·0			20 0·5	0·1	0 6·6	Doubt. as being seis.
1162	" 27	22 39·5	22 41·5	22 44·8		0·2		A. Ts. going on.
1163	" 29	8 2·6	8 10·6		8 23·6	0·2	0 21·0	Marked thickenings.
1164	July 7	8 5·6 V$_2$ 8 12·4	8 16·9	8 21·4) 8 22·7) 8 24·2) 8 37·0)	10 54·0	13·9 10·0 15·0 6·5	2 48·4	Three marked max. Alaska.
1165	" 7	22 6 6 V$_2$ 22 10·9	22 14·7) 22 17·5)	22 18·3	23 32·5	2·5	1 25·9	
1166	" 9	23 1·1			23 7·3	0·05	0 6·2	
1167	" 9	23 24·9			23 26·9	0·05	0 2·0	
1168	" 19	13 16·3			13 24·7	0·2	0 8·4	Uniform thick'ings.
1169	" 23	22 59·1			23 3·8	0·05	0 4·7	
1170	" 24	12 9·8	12 14·4	12 23·5	13 57·0	0·8	1 47·2	Pera.
1171	" 25	23 26·8	23 43·2		23 50·0	0·2	0 23·4	tion of last dist.
1172	" 26	0 2·6		0 6·9	1 3·6	0·3	11·6	May be a continua-

Alaskan Eqs.

Period 14·7 seconds. 1 mm. = 0″·64.

VICTORIA, B. C.

E. B. REED, SUPERINTENDENT.

No.	Date 1912	P.T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1111	June 3	0 12·8			0 16·0	0·050	0 3.2	Doubtful as to being seismic.
1112	" 3	12 45·2		13 1·9	13 37·8	0·3	0 52·6	
1113	" 6	15 16·8		15 20·9	15 25·4	0·2	0 9·6	
1114	" 6	16 21·2			16 25·4	0·050	3·8	
1115	" 6	16 43·5			16 53·5	0·050	10·0	Minute thickn'ings
1116	" 6	17 24·4			18 35·0	0·050	1 10·6	Min. thickenings
1117	" 6	19 23·7	Thicken'g	more or less	2:h 34m	0·05		
1118	" 6	22 1·9		22 9·4	22 25·9	0·2	0 24·0	Thickenings
1119	" 6	22 39·5			23 20·6	0·050	41·1	
1120	" 6	23 32·3		23 38·4	0 34·4	0·050	2 1	Thickenings
1121	" 7	3 46·4		3 53·3	4 21·0	0·2	3 4·6	
1122	" 7	4 43·4		4 46·4	6 31·0	0·2	1 5·6	Thickenings
1123	" 7	6 45·0		6 49·5	7 07·0	0·3	0 22·0	
1124	" 7	7 08·5		7 09·0	8 04·0	0·3	0 55·5	
1125	" 7	8 10·0		8 16·0) 8 18·0)	8 45·0	0·4	0 35·0	
1126	" 7	9 4·0		9 6·3	9 27·0	0·4	0 23·0	
1127	" 7	10 2·3	10 4·5	10 11·3		1·4	coatin'ed to next	
1128	" 7		10 43·3	10 46·0	12 11·0	0·8	2 8·7) 1 27·7)	A continuation but a distinct dis.
1129	" 7	12 27·0	12 34·0	12 38·5	13 32·0	0·8	1 5·0	Marked.
1130	" 7	14 23·5	14 30·5	14 31·3	14 43·5	0·5	0 20·0	
1131	" 7	18 28·7	18 32·8	18 38·4) 18 40·4)	20 4·8	1·5	1 36·1	Double max.
1132	Came on whilst attending to instruments and boom continued more or less disturbed at 12·2 up to 14 48 of the 8th. Following are the times of the most marked portions.							
1133	" 7		20 33·3			0·1		
1134	" 7		20 35·6			0·1		
1135	" 7		20 38·8			0·1		
1136	" 7		22 54·4			0·05		
1137	" 7		23 0·5			0·05		
1138	" 8		0 7·5			0·1		
1139	" 8		0 26·3			0·1		
1140	" 8		0 28·8			0·1		
1141	" 8	1 7·8		1 10·8		0·3		
1142	" 8	1 27·8		1 29·3		0·3		
1143	" 8	2 23·6) 2 26·6)		2 24·6		0·3		
1144	" 8	3 1·8	3 3·8) 3 8·0)	3 6·3		0·8		
1145	" 8	4 42·3				0·1		
1146	" 8	5 11·7				0·2		
1147	" 8	5 32·6				0·3		
1148	" 8	6 20·5) 6 22·8)		6 27·5		0·8		
1149	" 8	6 38·4				0·3		
1150	" 8	6 53·3	6 57·2	7 1·8		1·8		
1151	" 8		7 40·4) 7 44·4)	7 48·4 7 50·6		8·6 9·9	Large	Double max. prolonged echoes,
1152	" 8		8 57·8	8 59·2		3·4		fore max. Sudden vib just be-

Alaskan Earthquakes.

Alaskan Earthquakes.

VICTORIA—(*Continued*).

No.	Date 1912	P.T. Comm.	L.W. Comm.	Max.	End.	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1153	" 8		10 9·8	10 11·0		1·7		
1154	" 8	10 40·3	10 42·6	10 43·9		0·8		(before 13h 40m,
1155	" 8	13 4·0	13 8·8	13 11·8	14 48·0	2·9	1 44·0	Boom fairly steady
1156	" 9	7 2·8		7 9·3	7 15·8	0·1	0 13·0	
1157	" 9	7 51·0			7 56·1	0·050	5·1	
1158	" 9	8 30·4	8 32·5	8 33·5	8 46·5	0·3	0 16·1	
1159	" 9	17 23·6	17 25·6	17 26·6	17 46·5	0·8	0 22·9	Small.
1160	" 9	21 46·8	21 49·2	21 50·2	22 4·8	0·3	0 18·0	(dis.
1161	" 9	22 14·4	22 20·6	22 21·8	23 15·7	0·8	1 01·3	May be part last
1162	" 10	11 54·5				0·05		Doubt'l as to being
1163	" 10	12 10·6			12 12·6	0·050	2·0	Zigzag line. (seis.
1164	" 10	12 45·3			12 47·3	0·050	2·0	
		10th line became wavey at 13h 6m·6 caused either by an insect or air tremors until appearance of next disturbance.						
1165	" 10	16 10·2?	16 10·8	16 18·5	18 23·0?	5·9	A. Ts.	Large swings by land at 16h 17m·4.
1166	" 12	7 9·1	7 15·3	7 16·6	8 10·1	0·8	1 1·0	Small well defined.
		V$_2$ 7 12·6 x Marked oscillation						
1167	" 12	12 52·1						
		V$_2$ 12 58·0	13 14·6	13 17·5	14 3·7	0·7	1 11·6	Long duration L. W's.
		Air tremors going on during the morning of 13th. Line zig zag at 1h 08m·4 of the 14th						
1168	" 17	11 29·0	11 39·0	11 42·4	12 31·5	0·8	1 02·5	Well defined.
1169	" 18	12 11·0			14 1·5	0·2	1 50·5	Thickenings
1170	" 24	10 44·2		10 44·5	10 48·2	0·2	0 4·0	Grad. thickenings
1171	" 29	8 13·7			8 31·9	0·050	18·2	M in. thickenings
				8 9·7		9·9		
1172	July 7	8 1·8	8 5·8	8 10·8	11 10·5	10·2	3 8·7	Alaska. Rapid vib. just before and after max.
				8 11·9		16·0		
1173	" 8	21 59·3	22 3·9	22 6·7	23 35·7	4·0	1 36·4	Medium
1174	" 9	23 1·1			23 11·1	0·050	10·0	ling seismic
1175	" 9	23 35·0			23 35·5	0·050	0·5	Doubtful as to be-
1176	" 19	13 4·8		13 5·3	13 18·7	0·3	0 13·9	Sud. little dis.
1177	" 23	22 58·6			23 4·0	0·050	5·4	
1178	" 24	12 9·5	12 17·7	12 18·3	14 05·6	0·3	1 56·1	Beg. grad. Peru
1179	" 25	No P.Ts.	23 30·4	23 30·7	0 13·0?	0·2	0 42·6	Thickening

Alaskan Eqs.

Period 15 seconds. 1 mm. = 0″·76

J. V.

ASTRONOMICAL NOTES

THE MOON'S DIAMETER DURING SOLAR ECLIPSE. — For the last ten years the British and American almanacs have recognized the necessity of using a smaller diameter of the moon for solar eclipses than for occultations of stars; for the lunar valleys permit the sun to shine through them and effectively reduce her diameter. The German and French almanacs have not hitherto allowed for this, and have given durations of totality that were too long by five seconds. This eclipse, (Total Solar Eclipse, April 17, 1912), has settled the point decisively in favor of the British eclipse value, and no doubt all the almanacs will now fall into line.

It was par excellence a "Baily's bead" eclipse. The disappearing and reappearing crescents were broken up by saw-like teeth — the lunar peaks seen in profile and enlarged by the irradiation that increases the apparent width of the bright crescent. These lunar peaks could also be clearly seen during the partial phase, some of them indicating steep mountains rising to a height of two miles above the surrounding plain.

Eclipse Shadow Bands.— These were very well seen at St. Germain by M. and Mme. Antoniadi on a white sheet stretched on the ground. They appeared as irregular wavy bands, some darker than others, about six inches apart, which moved very rapidly with a wriggling motion like snakes in the direction from south-southwest to north-northeast (that is, nearly away from the sun, and also nearly in the direction of the wind). The peculiar feature was that they moved in the direction of their own length; these directions are generally inclined at a large

angle; the direction showed no rotation, such as was plainly detected at Majorca in 1905. There is little doubt that these bands are connected with atmospheric waves arising from the rapidly falling temperature, and also with the slit-like shape of the source of light, but the reasons for their capricious behavior are far from clear.—*Pub. Astronomical Society of the Pacific*, No. 142.

GERMAN COMPOUND WORDS.— In an appreciative review of a new edition of Klinkerfues "Theoretische Astronomie," by Dr. Buchholz, of Braunschweig, Germany, Professor F. R. Moulton, *Popular Astronomy*, No. 6, concludes: — "It is needless to say that the book is in the German language. The English speaking person who reads it will get an increased respect for the possibilities of forming compounds from German words, and will be ready to believe there is no limit to the length they may attain. A good example is the word

Aequatorealhorizontalparallaxenwinkels.

CLUSTER TYPE, VARIABLE STARS.— Only a few of the large number of clusters that are scattered throughout the sky have been observed to contain variables; and these few — 23 in number — are not equally rich in the number of variables they possess. For the 23 clusters listed the number of variables that each possesses is roughly proportional to the degree of condensation of the cluster; although one notable exception is the great cluster in Hercules, in which only two variables have been found. In addition to the clusters, certain nebulæ and the Magellanic Clouds have been observed to contain variable stars, the number of variables observed in the latter being 1,777.

More surprising than the fact that variable stars are present in clusters, was the fact that in the great majority of instances the variation is of a new type. First of all, the "cluster variables" periods of range in duration from $0^d{\cdot}4$ to $0^d{\cdot}7$, whereas the duration of light change of the ordinary short-period variables is from $0^d{\cdot}2$ to $44^d{\cdot}6$, the mean for 98 Cepheid-Geminid stars being $9^d{\cdot}2$. Secondly, the change in light of variables of the cluster type is not continuous, as is the case with Cepheid-Gem-

inid stars, but at minimum there is a prolonged halt lasting on the average one-third of the period.

A small number of isolated stars not situated in or near clusters have been found to possess short-period variation of the cluster type. In almost every respect these stars resemble their prototypes in clusters: their periods average about half a day; their variation in brightness averages one magnitude; the minimum phase occupies approximately one-third of the entire period; and the rise from minimum to maximum is very rapid. However, although these stars are faint, there is no such uniformity in their maxima as is the case with variables in clusters.

The variation-in-absorption theory, accounts for the changing intensity of the light of the variable by supposing that as it swings about its darker primary its atmosphere is brushed back by the extended corona of the primary. Thus, on the advancing side of the bright member of the system, the atmosphere is not so deep, and consequently the absorption not so great, as on the following side.

The brighter component of the binary system is a variable whose light-change is due to change in the absorbing powers of its atmosphere. Maximum brilliancy occurs at quadrature, but as the following side of the star gradually comes into view the light wanes until it is cut off in eclipse by the passing of the variable behind its larger and less brilliant primary. The minimum phase of the light curve, which extends over nearly a third of the period, represents the constant and steady light which we receive from the primary, while the eclipse of the secondary is in progress.— C. C. KIESS, in *Publications Astronomical Society of the Pacific*, No. 143.

DISTANCE OF THE STARS.— The human mind finds itself placed between two infinities—that of the infinitely small and the infinitely great. From the bulb of one of these incandescent lights the maker has exhausted nearly all the air, yet there remain in it after this process a number of molecules millions of times greater than the total number of stars visible in the mightiest

telescope, particles smaller than the resolving power of any microscope, but moving rapidly in their minute paths, a microcosm of the infinitely small, as difficult to conceive of as the cosmos of the infinitely great. Great as is our own sun, we find it difficult to imagine that it is only a very ordinary and inconspicuous unit among hundreds of millions of similar units. That these millions of massive bodies should be travelling through space in all directions at speeds of five to ten miles in every second of time is likewise difficult to conceive, but more wonderful and difficult of conception than all is the vast realm of space in which they move under the influence of that still unsolved mystery, gravitation,—a space so vast than the distances apart of the separate units are to be measured by trillions and quadrillions of miles, a realm so nearly infinite in extent that it is practically so, as far as our finite-thinking minds can grasp it. Truly a supremely vast and supremely wonderful universe. And what may be still farther out, beyond that part to which our mightiest telescopes can reach? We do not know.—H. B. Curtis, in *Popular Astronomy*, No. 7.

New Comet. — Harvard College Observatory *Bulletin*, No. 494, announces that a comet was discovered by Gale, at Sydney, Australia, on September 8th, in position

R. A. $13^h\ 37^m\ 0^s{\cdot}1$. Dec. south $36°\ 31'\ 0{\cdot}2''$.

On September 11th — The comet was observed by Prayer at Santiago, visible to the naked eye

R. A. $13^h\ 54^m\ 02^s{\cdot}4$. Dec. south $33°\ 10'\ 50''$.

This would indicate the object on those dates to be in the Constellation Centaurus, about 25° south of the bright star Spica in Virgo, two hours east of the sun; and as having a motion of 4° east, and 3° north within three days.

Later computation of orbit is announced. Perihelion passage October 4th, 1912, distance from the sun at that time about 67,000,000 miles. Its position for October 1st

R. A. $15^h\ 19^m\ 04^s$. Dec. south $06°\ 00'$.

in the constellation Libra, in a direct line half way between the bright stars Arcturus and Antares. J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

MOON AND THE WEATHER

QUERY

We have had a great abundance of rain this summer; is there any connection between rainfall and the moon, as so generally believed? — J. J. T.

ANSWER

Scientific men have long sought for real observational evidence of the influence of the moon on the weather, but with little success. In W. H. Pickering's book on "The Moon" he states that a study of statistics at Greenwich for twenty-four years appeared to indicate a slight preponderance of rain at about the new moon. But this evidence is contradicted by other investigations, and indeed in itself is so weak that no certain conclusions can be drawn from it.

Recently, however, one of our daily papers published an interesting quotation from the *Westminster Gazette*, which I give below :—

"Mr. E. E. Nevill, F.R.S., who is resigning his directorship of the Natal Observatory and returning to England, is a leading authority on the lunar theory, and during his investigations into the moon's movements he has discovered what appears to be a definite association between the moon and periodical abnormal rainfalls in South Africa. Heavy rains occur there at intervals of nineteen years, which period synchronises with the lunar cycle of maximum north and south declinations. Mr. Nevill's theory is that the attraction of the moon on the earth's atmosphere causes a permanent cloud-belt to drift with it, and that the amplitude of the drift is so great when the moon is nearing its furthest point north of the equator that the mass of clouds impinges on the mountains in Natal and precipitates the excessive rains. This is said to be the first scientific explanation ever adduced in support of the prevalent belief that our weather is influenced by the moon."

LUNAR EXHIBITION AT BARCELONA

In the JOURNAL for January–February the present writer referred to the General Exhibition of Lunar Studies which the Astronomical Society of Barcelona, Spain, proposed to hold during May and June of this year. The Exhibition was held at the University of Barcelona and was a brilliant success. The formal opening took place on May 26, under the presidence of the Rector, who was assisted by the civil, military, university and other academic authorities of the city and by a high representative of the King, who is Honorary President of the Society.

The Exhibition was open until the 30th June, and the people of the city and neighboring towns took a very lively interest in it.

The Society issued a General Illustrated Catalogue of the exhibits. This contains over seventy pages, and includes a large number of reproductions of portraits, of photographs of different sections of the Exhibition, of old lunar charts and of modern photographs and drawings of the moon. Contributions were received from almost every country in the old and new worlds. The pictures, besides giving an excellent view of the manner in which the exhibits were arranged, show that the rooms in which they were placed are decorated in a sumptuous and beautiful manner.

In the Exhibition there was a portion devoted to Spanish Meteorology, which proved extremely attractive to the visitors. This subject is receiving great attention and is developing favorably in Spain.

Another portion contained almost all the works concerning the moon from the time of Galileo to the present.

The Barcelona Society is highly gratified with the success of the Exhibition, and looks forward to the rapid development of Astronomy. The Society was the first to be founded in Spain, and though it was only instituted in January, 1910, it now has a membership of over 400, amongst whom are the most eminent Spanish men of science.

The Society owes much to Mr. Salvator Raurich, its energetic and capable Secretary.

DEDICATION OF THE NEW ALLEGHENY OBSERVATORY

An interesting feature of the meeting of the Astronomical and Astrophysical Society of America held at the end of August was the dedication of the new Allegheny Observatory on August 28. This institution has had a very honorable history, and is still doing admirable work. It is now the astronomical department of the recently organised University of Pittsburgh, and the chairman of the Observatory Committee is Dr. John A. Brashear. To his noble spirit and high enthusiasm is largely due the magnificent institution just dedicated. We hope to include a full account of the meeting of the Society in the next issue.

"WHO IS KHAN IN THE MOON?"

Col. Burnaby in his interesting book "A Ride to Khiva," a work giving an account of an adventurous trip made in 1875-6, but which is not yet out of date, tells an interesting story of the Ameer of Bokhara.

"By all accounts he was not a very enlightened ruler, and it was said of him that on one occasion he sent to a Russian Officer, who had been seen looking at the moon through a telescope, and inquired what it was he could see there. 'Mountains and extinct volcanoes' was the answer. 'Dear me!' said the Ameer, 'how very curious. Pray, who is the Khan in the moon. I should like to make his acquaintance.'"

Here we see another illustration of the common belief in life in other worlds.

C. A. C.